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APPLICATION FOR LETTERS PATENT

INVENTOR:

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TITLE:

A Residential Gateway System for Automated Control of Residential Devices

BACKGROUND OF THE INVENTION

Field of Invention

The present invention relates generally to the field of residential networks. More specifically, the present invention is related to automated control of residential devices using a residential gateway.

Discussion of Relevant Art

Generally, a residential gateway is a device that connects an in-home network (Intranet) to a, typically broadband, Internet connection (e.g., digital subscriber line (DSL), cable, satellite, etc.), which enables data communication among networked devices in the home and across the Internet. Accordingly, residential gateways typically combine the functions of a router and hub to provide for device connectivity and Internet access. Some residential gateways have an integrated broadband modem to connect to the broadband connection, while others rely on external modems. In more advanced residential gateways, the layer **2** switch (hub) even provides bridging across multiple networking technologies, such as Ethernet, Home Phone Line Networking Alliance (HPNA), IEEE 802.11b (Wi-Fi) wireless, Bluetooth wireless, USB point-to-point networking, etc. Thus, a residential gateway allows a number of different devices to be networked together (with advanced models bridging between network technologies) and share access to the Internet across a broadband connection.

U.S. Patent Publication 2001/0034754 describes a customer premises gateway that is connected between the Internet and an in-home network. The in-home network consists of a

number of different "smart" devices in the user's home that are coupled to the gateway via different networking technologies. The customer premises gateway also provides a Markup-Language interface, e.g. XML or HTML, that allows the user to remotely provide commands to the devices connected to the in-home network, which, in effect, provides remote control of their behavior. For instance, a user can access the Internet from a location remote to their home, point a Web browser to the customer premises gateway, and send commands to turn their lights on and off, turn a sprinkler system on and off, control their CD player, etc. The customer premises gateway, therefore, provides a passive interface to the in-home network, allowing a user to manually issue commands to the devices on the in-home network from a remote location. The customer premises gateway, however, does not provide automatic control of a discrete device on the in-home network based on relevant data accessed from the Internet.

SUMMARY OF THE INVENTION

One aspect of the present invention provides a residential gateway connecting an Internet connection to an in-home network that comprises at least one residential device connected to the residential gateway. The residential gateway comprises a software module that receives control parameters from a control server via the Internet connection and causes the residential gateway to communicate with the residential device to provide control of the residential device based on the received control parameters. The control server determines the control parameters from relevant control information accessed from an information server on the Internet and operational information of the residential device.

Another aspect of the present invention provides a system for providing automated control of at least one residential device connected to an in-home network. The system comprises a residential gateway that connects the in-home network to an Internet connection and a control server that determines control parameters for controlling the residential device. The control parameters are determined from relevant control information accessed from an information server on the Internet and operational information of the residential device. The residential gateway comprises a software module that receives the control parameters from the control server via the Internet connection and causes the residential gateway to communicate with the residential device to provide control of the residential device based on the received control parameters.

Another aspect of the present invention provides a method of providing automated control of at least one residential device connected to a residential gateway. Relevant control information is retrieved from one or more information servers on the Internet and operational information of the residential device is tracked. Control parameters of the residential device are determined based on the tracked operational information and the retrieved control information. Te control parameters are communicated to the residential gateway via an Internet connection. The residential gateway then communicates with the residential device to provide control of the residential device based on the control parameters.

In a particular embodiment, the residential device is a home irrigation system and the information server is a weather station server available via the Internet.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a system according to the present invention in which a residential gateway provides for control of a residential device based upon control parameters received from a control server.

Figure 2 illustrates a preferred embodiment of the present invention in which the residential device is a home irrigation system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

While this invention is illustrated and described in a preferred embodiment, the device may be produced in many different configurations, forms and materials. There is depicted in the drawings, and will herein be described in detail, embodiment(s) of the invention, with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and the associated functional specifications for its construction and is not intended to limit the invention to the embodiment(s) illustrated. Those skilled in the art will envision many other possible variations within the scope of the present invention.

As illustrated in figure 1, a system according to the present invention comprises a residential gateway **100** that connects an in-home network to a broadband Internet connection. At least one residential device **107** that runs software supporting network communication capabilities is connected to the residential gateway **100**. Residential device **107** also has a application programming interface (API) that responds to queries about its current state and that controls residential device **107** in response to received control commands.

Residential gateway **100** runs gateway software **102** that controls routing and switching functions for providing network connectivity among devices of the in-home network connected to gateway **100**, including any bridging between network technologies supported by gateway **100**, along with access to the Internet. Internet connectivity is provided via a, preferably broadband, connection (e.g., a DSL, cable, or satellite connection) that is accessed using an external broadband modem **104** connected to residential gateway **100**. While an external modem is shown, it will be appreciated that a residential gateway incorporating an internal modem for Internet access is within the spirit of the present invention.

In addition to controlling routing and switching functions, gateway software **102** communicates with residential device **107** to provide control of residential device **107** based on control parameters received from control server **118**, which is accessed via the Internet **114**. Residential gateway **100** maintains a command set that is issued to residential device 107 to provide control of residential device **107**.

Control server **118** tracks information about the residential device's operation and determines the control parameters from this operational information and relevant control information accessed from sources, such as an information server **116**, accessible via the Internet. To perform tracking, residential gateway **100** periodically queries residential device **107** about its current state, which responds with operational information concerning its state. Residential gateway **100** forwards this operational information to control server **118**. Software running on control server **118** processes the operational information and control information to determine the control parameters that are used by residential gateway **100** to control residential device **107**.

A customer computer system **110** is also connected to the in-home network side of residential gateway **100** to provide the user with override and control capabilities and to display current and tracked operational information. Computer system **110** runs client software that communicates with residential gateway **100**, which in turn communicates with residential device **107**, to provide the user the capability of overriding the control parameters and to retrieve and display the current sate of residential device **107**. In addition, client software **110** also communicates with control server **118** to retrieve and display tracked operational information, and to allow a user to configure an economic setpoint of operation of residential device **107**. For instance, the user may want to limit the amount of electricity used by residential device **107** during a particular time period so as to keep electric costs low. In this case, residential device **107** will be controlled during the time period so as to not exceed the specified electric usage. Preferably, a mark-up language interface (e.g., HTML or XML) is used for override and to access and display operational information, in addition to configuring an economic setpoint.

Figure 2 shows a preferred embodiment of the present invention in which the residential device to be controlled is a home irrigation system **207**. The home irrigation system comprises sprinklers **208** that are controlled by an irrigation controller **206**. Sprinklers **208** have electrically controlled valves which controller **206** opens and closes according to a watering cycle to provide irrigation of the homeowner's lawn.

Irrigation controller **206** is connected to a residential gateway **200**, preferably through a wireless networking technology such as IEEE 802.11b. As previously described, gateway software **202** running on gateway **200** communicates with home irrigation system **207** to provide

control of system **207** based on control parameters received from control server **218**, which is accessed via the Internet **214**. The watering cycle (i.e., start time and length of time for watering) constitutes the control parameters for home irrigation system **206**. The control parameters are determined by sophisticated irrigation control software running on control server **218**.

Control server **218** tracks operational information of the irrigation system such as water usage and determines the watering cycle for the homeowner's irrigation system using this operational information, in conjunction with information about the climatic conditions in the homeowner's area (e.g., actual moisture in the air (humidity) and actual rain fall). A number of methods of determining optimal watering cycles from such climatic information and water usage are well known. Generally, the length of the water cycle can be determined from a value known as evapotranspiration. The length of an irrigation watering cycle should be such that an equal amount of moisture is returned to the vegetation as is lost through either evaporation from the soil or transpiration from the vegetation. The amount of water lost, and consequently the amount needed by the vegetation to maintain growth, is known as an evapotranspiration value. The evapotranspiration value for an area is normally calculated using climatic information such as temperature, humidity, etc. Climatic information is generally collected for a number of areas by weather stations located nationwide. Some networks of weather stations are connected to the Internet and, as a result, their collected climatic information can be accessed via the Internet. Typically, the information collected from the weather station network is stored on a weather station server **216** that is connected to the Internet **214**.

For example, one such weather station network whose information is available via the Internet is owned by AWS, Inc. Many of the weather stations in the AWS network are connected to a direct Internet connection with their information immediately available, while others are connected via a standard phone line/modem setup and polled periodically. In either case, a weather station server owned by AWS makes the climatic information collected by these weather stations available via the Internet. Information on the AWS system can be found at the Internet website http://ww3.weatherbug.com.

In addition, as previously described, via the client component **212** and customer computer system **210**, a user can configure an economic setpoint for the control of irrigation system **207**. For instance, the user may want to keep the water usage and electricity usage of irrigation system **207** below a certain point during each month so as to keep water and electricity costs low. As a result, control server **218** uses the additional operational information of electricity usage, in addition to water usage, to determine the optimal watering cycle at this given economic point configured by the user. This allows a user to be able to make economic decisions that may give less than optimal performance for his/her lawn, but may yield a lawn acceptable at a given economic point

Thus, control server **218** retrieves the homeowner's local weather conditions from a weather station server **216** that is available via Internet **214**. In addition, control server **218** tracks operational information of irrigation system **207**. From this climatic information and tracked operational information, in addition to any economic setpoint configured by the user, the irrigation control software running on control server **218** calculates the control parameters (i.e.,

water cycle) of home irrigation system **207**. The control parameters are then communicated to residential gateway **200**.

As previously described, the control parameters are communicated to residential gateway **200** via an Internet connection using an external modem **204** that is connected to gateway **200** through, for example, a 10Mb/s Ethernet interface. As will be appreciated by one of skill in the art, a different network interface can be used to connect external modem **204** to gateway **200**, or modem **204** can be integrated with gateway **200**, without departing from the scope or spirit of the present invention.

Based upon the communicated control parameters, residential gateway communicates with irrigation controller **206** to provide for control of the irrigation system **207**. As described, residential gateway **200** has a command set that it issues to irrigation system **207** to control irrigation system **207**. The residential gateway **200** issues commands to residential device **200** based on the control parameters and the API of irrigation system **207** causes irrigation system **207** to operate according to the commands received from residential gateway **200**.

A system and method has been shown in the above embodiments for the effective implementation of a residential gateway system for automated control of residential devices. While various embodiments have been shown and described, it will be understood that there is no intent to limit the invention by such disclosure, but rather, it is intended to cover all modifications and alternate constructions falling within the spirit and scope of the invention, as defined in the appended claims.